



公司现有铝及铝合金铸造、轧制拉伸、挤压，屏蔽绝缘母线制作，金具加工等专业化生产设备。装备有年铸造能力12000吨连续铸造生产线；国内最先进的无缝轧、拉生产线；自动绝缘制作生产线等。并力争成为中国最大的管母线生产加工基地。

The company possesses specialized production equipments for aluminium and aluminium alloys casting, rolling, drawing, extruding, insulation and shielding making, power fittings manufacturing; equipped with continuous casting line with production capacity of yearly output of 12,000 tons of aluminium products; internal advanced seamless rolling & drawing production line, automatic insulation manufacturing line, etc.. The company is striving to become China's biggest production base for tubular busbar.



变电站
Substation



无缝管材轧制设备
Rolling equipments for seamless pipe materials



熔铝及铸造
Aluminium smelting & casting



管材制头加工设备
Pressing equipments for pipe materials



▲ 管材挤压设备
Extruding equipments for pipe materials



模具加工中心 ▶
Mould machining center

绝缘制作设备 ▶
Insulation manufacturing equipments



▼ 管材弯制设备
Pipe bending machines





公司技术实力雄厚，是国家级高新技术企业，建立了省级企业技术中心。工厂质量检测设备齐全，拥有电器、机械、理化、精密测量等试验和检测设备，具备母线及相关产品的设计开发能力和完善的质量检测能力。

With abundant technical potentiality, the company has full sets of testing devices for electric, machinery, physical and chemical testing and precision measurement, it's the national new high-tech enterprise with perfect ability of quality testing and design and development for related products. The company has established a Technology Center of Provincial level.



直读光谱分析仪
Direct-reading spectrophotometer



化学分析仪
Chemical analyser



金相显微镜
Metallographic microscope



电气性能试验室 Electric property test house	万能材料试验机 Universal material testing machine
双臂电桥 Kelvin bridge	试验变压器 Testing transformer
	绝缘电阻测试仪 Insulation resistance tester





自公司建立以来，不断加强企业管理和科技创新，被认定为国家火炬计划重点高新技术企业，并多次荣获国家及省级优秀企业，先进单位（集体）等荣誉称号。



Since the company inception, continuously strengthen enterprise management and technological innovation has been recognized as National Torch Plan Key High-tech enterprises, and has repeatedly won national and provincial excellent enterprise, advanced units (collective) and other honorary titles.





An Enterprise Glory

公司荣誉



An Enterprise Glory

公司荣誉





湖北兴和电力新材料股份有限公司位于武汉城市圈内的黄冈高新技术开发区，是国内最大的电力母线生产企业和湖北省优秀民营企业，由湖北兴和铝业有限公司整体变更设立；公司注册资本5000万元，总资产近2亿元，主要从事电力铝及铝合金管型母线、复合屏蔽绝缘铜（铝）管型母线、电力金具、新型电线电缆等电力配套器材的生产经营和自营进出口业务，具有年产2万吨的电力材料加工能力；是国家《高新技术企业认定管理办法》及《认定指引》发布后被认定的湖北省2008年首批高新技术企业，2009年3月被国家科技部认定为国家火炬计划重点高新技术企业。

公司技术实力雄厚，已外聘教授级专家4人，拥有各类研发人员35人，其中高级技术职称13人，中级技术职称22人。建立了省级企业技术中心，已取得6项国家专利，拥有3项已通过初审的发明专利和3项已受理的实用新型专利及非专利核心技术19项。所有产品均通过了ISO9001质量体系认证。公司产品技术先进并保持国内领先地位。稀土铝合金管型导体被确定为国家重点新产品，高强度耐热铝合金管型母线经科技部门鉴定“达到国际领先水平”，铝合金管型母线的国内市场占有率连续多年保持第一位，并出口到印度、蒙古、塔吉克斯坦、尼日利亚、赞比亚、巴基斯坦、老挝等十多个国家；复合屏蔽绝缘铜（铝）管型母线产品被列入国家2008-2009年火炬计划项目，已通过国际电工行业知名企业ABB（中国）有限公司的严格审核，并首批为该公司提供产品和服务价值5000多万元，为国内近百所变电站及大电力用户提供了令人满意的产品和服务，在国内同行业名列前茅；雄厚的技术力量和研发能力，过硬的产品质量，使公司主导产品在竞争中始终保持领先地位，在农网、城网、西电东送、三峡输变电工程220kv、500kv变电站中得到大量应用；十一五期间国家开工建设的1000KV交流和±800KV直流特高压输变电工程均选用我公司电力管型母线产品。

展望未来，公司干部员工将继续发扬“诚信、团队、创新、责任”的企业精神，充分利用资本市场力量和湖北中部崛起的良机，不断开发高科技含量的电力材料系列产品，内抓管理，外拓市场，以人为本，服务社会，力争使公司“兴和”商标成为中国知名品牌，争取在“十一五”期间把湖北兴和电力新材料股份有限公司建设成为电力材料加工排头兵企业。

热忱欢迎社会各界人士来我公司考察、指导工作。



Hubei Xinghe Electric New Material Co., Ltd. was established from overall change of Hubei Xinghe Aluminium Co., Ltd., located in the high and new tech development zone of Huanggang City, which is the biggest national production enterprise for electric power busbar and Hubei Provincial excellent private enterprise. The registered capital of the company is CNY 50 million, total assets near CNY 200 million. The company mainly engaged in production operation and self-run I/E business of electric power materials such as electric aluminium and aluminium alloy tubular busbar, compound insulated shielding copper and aluminium tubular busbar, electric power fittings, new type power wires and cables, with yearly production ability of 20,000 tons of electric power materials. Having been approved as the first batch of new high-tech enterprises of Hubei Province in 2008 after the State issued "Management measures for recognition of qualifications of new high-tech enterprises" and "Recognition of qualification directions", the company has been approved by Ministry of Science and Technology as important new high-tech enterprise of the State Torch program.

With abundant technical potentiality, there are 4 external professors & experts, 35 research personnels in the company, 13 of them have senior technical title, 22 of them with middle level title. The company has established a Technology Center of Provincial level. It has obtained 6 national patents, 3 patents of invention have been passed the preliminary examination, 3 accepted practical new type patents, 19 non-patent core technologies, all products have been approved by the international quality assurance system of ISO9001.

The advanced technology keeps the company in the leading position in China. Its RE aluminium alloy tubular conductor has been confirmed as the Key new product of the State, the high strength heat resistance aluminium alloy tubular busbar identified to reach the international advanced standard by science and technology departments. Aluminium alloy tubular conducting products maintain the first national market share and have been exported to over 10 countries such as India, Mongolia, Tajikistan, Nigeria, Zambia, Pakistan and Laos; Compound insulated shielding tubular copper(aluminium) busbar products have been enrolled in the State Torch Program Project and passed the strict examination and verification by ABB(China)Co., Ltd., the world-famous enterprise in line of electrician. The company supplied the first batch of products and services with a total amount over CNY 50 million, and supplied satisfactory products to near 100 domestic substations & big energy consumers. Owing to its abundant technical strength, R&D capability and high quality the company takes the first place in the same line of business. These products have been widely used in the transformation of rural power network and Urban network, the West-East electricity transmission project of 220 kV & 500 kV, power transmission and transforming projects of the Three Gorges. During the 11th Five-Year Plan our electric power tubular busbar has been used in the transmission and transforming projects of 1000KV (AD) & ±800KV (DC) super high voltage constructed by the State.

Looking forward to the future, all our staff will continue to carry forward the enterprise spirit of "Honesty, Team, Innovation and Liability", make full use of the force of capital market and the good opportunity of "Hubei's Rise of Central China Plan", keep on cultivating serial products of high technical electric power materials, improve management from inside and develop the market both home and abroad and serve the society on the basis of taking the need of people into first consideration; we will make our brand name "XINGHE" well-known in the country and make our company the leading manufacturer in the line of electric power materials during the 11th Five Year Plan.

We sincerely welcome people from all social circles to our company to guide our work and negotiate business with us.



一、铝合金管母线

(1) 产品的用途

铝合金管母线产品是公司目前的主要产品，也是公司未来发展的基础。主要用在我国电力建设工程中电网输电导线与变电站变压器之间的导体连接、输电线路中的跳线、电力设备中的连接导体以及大电流直流融冰装置中作过流导体，是取代传统的矩形、槽形、棒形母线和软导线的全新导体，是电力输电系统中最关键的设备（材料）之一，对输电系统及电力设备的安全、可靠运行起着至关重要的作用。

(2) 产品性能

该系列产品具有独特的材料性质（LDRE稀土铝合金、6Z63耐热铝合金等）、结构形式和加工工艺，拥有1项已授权的实用新型专利、2项已通过初审及1项申报已受理的发明专利、2项申报已受理的实用新型专利，是一种新型节能的母线导电材料，是传统钢芯铝绞线、槽型、矩型铝母线的技术替代产品。

主要性能体现在：

(a) 管型导体（母线）采用国内先进的热顶铸造无缝管三辊穿孔热轧冷拔加工及形变热处理工艺，表面光滑，尺寸精度高，抗拉强度大，不易产生放电和变形；

(b) 产品具有优良的加工、焊接、导电及耐热性能。产品经科技部门组织鉴定，达到国际先进水平（黄冈市科技局黄科鉴字[2009]第1号）；

(c) 对流散热条件好，温升低，损耗小，导电能力强、载流量大（国网武汉高压研究院《试验报告》2008缆字第S13号）；

(d) 安装占地面积小，组合管母线是软导线占地面积的1/3；

(e) 抗腐蚀，不易覆冰、抗灾能力强，使用寿命长；

(f) 安装方便，外形美观，运行安全、稳定、可靠，便于检修和维护。

(3) 产品外观

产品为空心管形结构，表面光泽，外形美观，尺寸均匀。外径尺寸从 $\phi 60\text{mm}$ 到 $\phi 250\text{mm}$ ；壁厚从3mm到12mm，单根长度根据客户需求，最长可达15米。



一、ALUMINIUM & ALUMINIUM TUBULAR BUSBAR

(1) Product application

Aluminium alloy tubular busbar is the main product and the future development foundation of the company. Mainly applied to the state power construction projects for the connection of conductors between transmission line and substation transformer, transmission jumper line and bonding conductors of power equipments, also applied as overcurrent conductors of heavy direct current de-icing devices, substituting conventional rectangle, flute profile, clavate busbar and soft conductors, as a brand new conductor, it's one of most critical facilities (materials) in power transmission and transformation system and plays a crucial role in the safe and reliable operation of electric power transmission and transformation system.

(2) Product Performance

The serial product has unique material property (6063 Re aluminium alloy, 6Z63 heat-resistant aluminium ally, etc.), form of structure and process technology, with one authorized new practical type patent, two patents of invention passed the preliminary examination and another one accepted, it's a new type energy-saving conducting material and substitute product of conventional ACSR, groove profile and rectangular aluminium busbar.

Main Performance:

(a) Tubular conductor (busbar) has been adopted internal advanced hot-top casting of seamless pipe three-roll piercing hot rolling cold draw process TMTP (thermomechanical treatment process), with smooth surface, dimensional precision, high tensile strength & less possibility of discharge & deformation.

(b) The product has excellent performance of processing, welding, conducting and heat resistance, and reached advanced world standard identified by departments of science and technology 【Technical Bureau of Huanggang City (HUANGKEJIANZI No.1, 2009)】.

(c) With good condition of thermal convection, low temperature rise, less power loss, high conductivity, high ampacity (Wuhan High Voltage Research Institute, State Grid Corporation of China).

(d) The installation covers less area, the site area of combined busbar is 1/3 of that of soft conductor.

(e) Anticorrosion, less ice coating, strong ability of preventing disaster, long service life.

(f) Easy mounting, artistic appearance, operation stability and safety reliable, easy access & maintenance.

(3) Product appearance

The product is of hollow tubular structure, smooth surface, artistic appearance and uniform dimensions. Outer diameter is from $\phi 60\text{mm}$ upto $\phi 250\text{mm}$, thickness from 3mm to 12mm, joint length as per customer's need, the length limit upto 15 meters.



▶ 下图是公司电力铝合金管型母线在各电力工程中的应用
The following is the application of aluminium & aluminium tubular busbar in projects



用于变电站、换流站导体
Applied to conductors of substation & convertor station



用于跨路母线
Applied to crossover tubular busbar



用于户外支撑母线
Applied to outdoor busbar supports



用于户外悬吊母线
Applied to outdoor busbar suspension



用于户外设备连接母线
Applied to outdoor apparatus busbar connection



用于敞开式组合电器连接母线
Applied to open type GIS busbar connection



用于线路跳线连接
Applied to jumper wire connection

二、复合屏蔽绝缘铜（铝）管母线

2.1 绝缘铜管母线的特性及其优点

2.1.1 载流量大

铜管母线为空心导体，截面大，导体表面电流密度分布均匀，铜管导体 $\phi 100 \times 10\text{mm}$ ，截面积：2826mm²，载流量：4000A，电流密度1.42(A/mm²)，额定电流温升=40K。因此，铜管母线特别适合工作电流大的回路。

2.1.2 集肤效应低、功率损失小

复合屏蔽管母线桥的集肤效应系数低， $K_f \leq 1$ ，交流电阻小，因而母线的功率损失小。若采用多片长形导体，随着片数增加，集肤效应系数不断加大，单位截面的有效载流量下降，片与片之间电流分布不均匀，附加损耗加大，散热条件差。

2.1.3 散热条件好、温差低

复合屏蔽管母线桥为空心导体，母线内径风道能自然形成热空气对流，（室内和室外的气压差，能自然形成热空气对流），散热条件好温升低。

2.1.4 允许应力大、机械强度高

复合屏蔽管母线桥的允许应力为矩形的4倍，可承受的短路电流大，机械强度高，使得母线支撑跨距加大。在50kA短路电流情况下， $\phi 100 \times 10\text{mm}$ 铜管母线跨距可达到12米。由于母线跨距大，可直接进入高压室与户内限流电抗器或35千伏开关柜连接，减少了相应的母线支撑点、母线金具、以及土建构架基础。

2.1.5 电气绝缘性强

复合屏蔽绝缘管母线采用屏蔽密封复合绝缘方式，外壳接地电位为零，由于电气屏蔽具有：(a)使电场分布均匀，(b)控制电位和限制电场，(c)避免在绝缘表面产生局部放电，(d)传导泄露电流和充电电流，(e)对危险的接触电压进行防护等特性，故这种屏蔽绝缘电缆导体管母线电场分布均匀，电气绝缘性强。

2.1.6 绝缘安全系数高

绝缘铜管母线主绝缘材料采用聚四氟乙烯，可在-250℃~+340℃中工作，有优良的电气性能和化学稳定性，介质损耗小，阻燃、耐老化、使用寿命 ≥ 30 年。

2.1.7 抗电气震动能力强

直接将绝缘铜管母线固定在钢构架上或混凝土支架上，取消穿墙套管和支柱绝缘子，具有较强的抗震动能能力。

2.1.8 不受环境干扰、可靠性高

绝缘铜管母线每相是密封屏蔽绝缘，内部无凝露产生，且消除了外界潮气、灰尘以及外物所引起的接地和相间短路故障，运行具有高度的可靠性。相比之下，矩形母线暴露在环境中，容易受人、动物（如老鼠等）以及其他物体偶然接触而发生接地和短路，不利于安全运行。

2.1.9 母线架构简明、布置清晰、安装方便、维护工作量少。

2.1.10 每项工程均需对工程现场实地勘测、设计及布置母线路径、现场安装、指导及调试。属于“交钥匙”工程，真正做到为用户排忧解难。

二、COMPOUND INSULATED SHIELDING COPPER(ALUMINIUM) TUBULAR BUSBAR

2.1. The characteristics and advantages of insulated copper tubular busbar

2.1.1 large current capacity

Copper tubular busbar is hollow conductor with large cross section and even current density distribution. The size of Copper tubular conductor is $\phi 100\text{mm}$, and the cross section is 2826mm², the current capacity is 4000A, the current density is 1.42(A/mm²), the temperature rise of rated current =40K. So, copper tubular busbar suits for the circuit with large operation current.

2.1.2 Low skin effect and low power loss

Regarding the complex shielding tubular busbar, the skin effect factor is low $K_f=1$ and AC resistance is low, so the power loss is low.

But for the rectangle conductor, along with the sheet added the skin effect will be larger, the effective current capacity of unit section will be decreased, the current distribution between sheets will be uneven, additional loss will be large and the radiation condition will be worse.

2.1.3 Good heat dispersion and low temperature difference

Complex shielding tubular busbar is hollow conductor, the hot air convection can be formed naturally in the inner diameter ducts of busbar. So the heat dispersion is good and temperature difference is low.

2.1.4 Large allowed stress and high mechanical strength

The allowed stress of complex shielding tubular busbar is 4times as strong as rectangle busbar, which has large withstand short circuit current and high mechanical strength cause the support span of busbar increased. On 50kA short circuit current, the span of $\phi 100\text{mm}$ copper tubular busbar can reach 12m. So the indoor limiting reactor or 35kV switch cabinet can be connected in the high voltage chamber, the related support, fittings and civil work can be reduced.

2.1.5 Strength insulation

Complex insulation shielding tubular busbar adopts a way of complex shielding sealed insulation. The surface ground potential is zero. The complex insulation shielding tubular busbar has uniform electric field distributions and strong electric insulation because electric shielding has properties below: (a) it can make electric field distributions uniform, (b) it can control electric potential and confine electric field, (c) it can prevent partial discharge caused on the insulation surface. (d) it can transmit leakage current and discharge current. (e) it can protect the risk contact voltage.

2.1.6 High insulation safety factor

The main insulation material is PTFE which can work under -250℃~+340℃ condition, excellent electric properties and chemical stability, low medium loss, flame retardant, aging resistance and life is more than 30years.

2.1.7 Strength electric vibration resistance

Fix insulated copper tubular busbar on the steel framework directly and remove wall bushing and supporting insulator. It has strong vibration resistance.

2.1.8 Without interference from the environment, high reliability

Each phase of insulated copper tubular busbar is sealed insulation shielding in which no condensation can be caused. The grounding and phase short circuit faults caused by moisture, dust and others had been prevented. So the operation of insulated copper tubular busbar has high reliability.

In contrast, rectangle busbar is exposed in the air, grounding and short circuit can be caused easily by the casual contact of human, animal and others which against operation in safety.

2.1.9 Simplified bus-bar framework, clear arrangement, easy mounting, less maintenance

2.1.10 For each project we should make necessary site survey, design, layout of busbar route, field installation, guidance & debugging, as it belongs to Turn key project, Really solve problems for users.



2.2 以下是绝缘母线在工程中的应用
The following is the application of insulated busbar in projects.



用于户外架空
Applied to outdoor overhead busbar



大电流双层布置
Layout for double layer of Heavy current



用于大跨距布置
Applied to layout of large span



用于狭窄空间布置
Applied to layout of narrow space



用于融冰工程
Applied to de-icing projects



用于户内架空布置安装效果
Applied to layout of indoor overhead installation



用于电抗器设备连接
Applied to reactor device connection



绝缘母线安装附件
Mounting accessories for insulated busbar

1、铝及铝合金管母线

Aluminium & Aluminium Tubular Busbar



2、复合屏蔽绝缘铜(铝)管母线

Compound insulated shielding copper(aluminium) tubular busbar

2.1 复合屏蔽绝缘母线结构形式

Structure of complex insulated shielding busbar

- 母线系统的导体用圆形铜管、铝合金管、棒。

The conductor of busbar can be round copper tube, aluminium alloy tube or bar.

- 采用复合绝缘材料在恒温恒湿无尘环境下，直接复合在导体上。

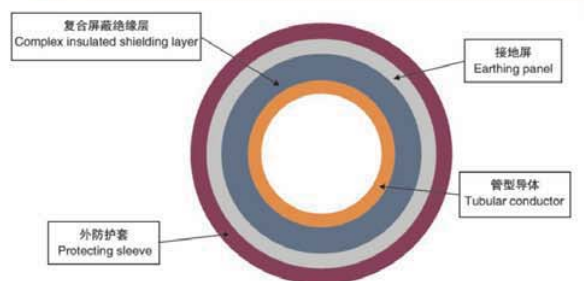
The main insulation material is the complex of compound insulated material combined on the conductor directly under the condition of constant temperature, constant humidity and dust free.

- 为控制电场分布构成完整的电屏蔽，在制作复合绝缘过程中，加入导电的电容屏，并在绝缘层中放入全长的接地屏。

Add capacitance plate around the busbar and put the full length ground plate into the insulated layers in the process of the complex of insulated layer so as to control electric field distribution to make up the complete electric shielding.

- 沿母线全长，在绝缘层表面热缩密封式护套管，有效地防止辐射、凝、露、霜及雨水的进入。

Put sealed heat sleeve on the surface of insulated layer by pyrocondensation along the whole busbar to prevent radiation, freezing, dew, frost and the rains



2.2 复合屏蔽绝缘母线型号表示方法

Representation methods for compound insulated shielding tubular busbar



例如：10kV 4000A规格复合屏蔽全绝缘铜管母线标识方法为：FPTM-10kV/4000A

For example: Size 10KV/4000A compound fully insulated shielding copper busbar represented as FPTM-10kV/4000A

10kV 2500A规格复合屏蔽全绝缘铝管母线标识方法为：FPLM-10kV/2500A

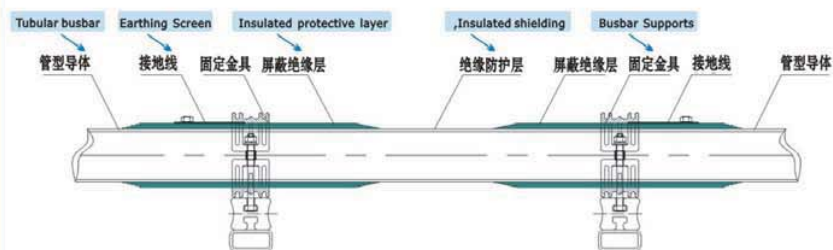
Size 10KV/2500A compound fully insulated shielding aluminium busbar represented as FPLM-10kV/4000A

2.3 分段式绝缘母线结构形式

Structure of sectional type insulated busbar

2.3.1 采用分段式全屏蔽的绝缘形式：在母线固定点的区域采用全屏蔽的绝缘形式，其固定采用金属固定金具固定。而在非固定点以外区域采用绝缘防护处理。

Insulation Style of sectional fully shielding: Insulation style of fully shielding adopted at the fixed point area, the fixation of which adopting metal busbar supports(MGG), whereas protective treatment made to area apart from the fixed point area.

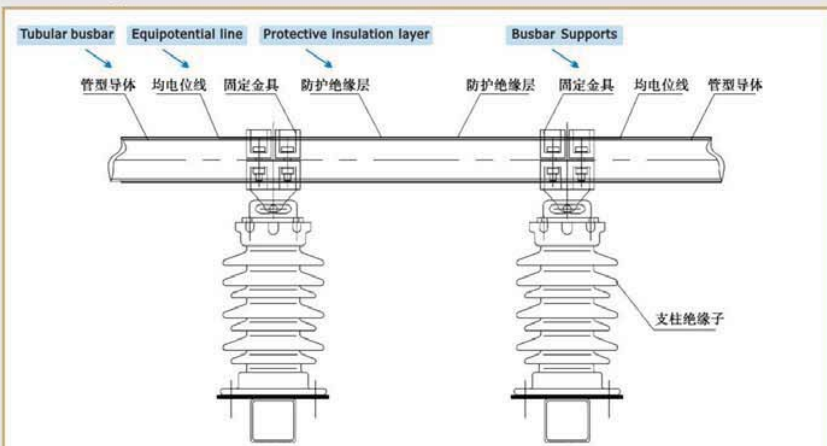


复合半绝缘管母线屏蔽式结构及布置形式示意图

Structure and Layout Diagram of Compound Semi-insulated Shielding Busbar

2.3.2 采用支柱绝缘子的绝缘形式：母线全长均采用防护绝缘处理，绝缘及固定采用支柱绝缘子形式。

Insulation style of pole insulator: to adopt insulation protective treatment to the full length of the busbar and use pole insulator for insulation and fixation.



复合分段式(半绝缘)管母线支柱式结构及布置形式示意图
Structure and Layout Diagram of Compound Semi-insulated Tubular Busbar of Pole Insulator Style

2.3.3 分段式绝缘母线型号表示方法

F □ □ - □ / □

额定电流 Rated current
 额定电压等级代号 (Kv) Code no. of Rated voltage grading
 分段式FB (屏蔽绝缘) FZ (支柱绝缘)
 Sectional Type FB (insulated shielding), FZ (pole insulator)
 TM铜质母线 LM铝质母线 TM copper busbar LM aluminium
 复合型F F compound type

例如：10kV 4000A规格分段屏蔽式绝缘铜管母线标识方法为：FTMFB-10kV/4000A
 For example: Size 10KV/4000A sectional type insulated shielding copper busbar represented as FTMFB-10kV/4000A.

10kV 2500A规格分段支柱式绝缘铝管母线标识方法为：FLMFZ-10kV/2500A
 Size 10KV/2500A pole insulator type insulated aluminium busbar represented as FLMFZ-10kV/4000A.

2.4 适合安装环境:

Applicable installation environment:

2.4.1. 复合屏蔽式 (FP) 管母线桥: 适用于室内、室外场合, 特别适用于弯曲、爬升、穿墙、大跨距及电缆层、电缆沟等各种复杂场合; 复合分段式 (FB或FZ) 管母线桥: 适用于户外架空, 特别适用于弯曲、爬升、穿墙、大跨距的场合。

Compound shielding (FP) tubular busbar (or bridge) applicable for outdoor overhead, especially for bending, climbing, passing through walls and on occasions of large span

2.4.2. FPTM-10/4000为10kV/4000A复合屏蔽绝缘铜管母线桥, FTMFB为复合分段屏蔽式铜管母线桥, FTMFZ为复合分段支柱式铜管母线桥

FPTM-10/4000 represents 10kV/4000A compound insulated shielding copper busbar (or bridge), FTMFB is compound sectional shielding copper tubular busbar, FTMFZ is compound sectional pole insulator copper busbar

2.4.3. FPLM-10/4000为10kV/4000A复合屏蔽绝缘铝管母线桥, FLMFB为复合分段屏蔽式铝管母线桥, FLMFZ为复合分段支柱式铝管母线桥

FPLM-10/4000 represents 10kV/4000A compound insulated shielding aluminium busbar (or bridge), FLMFB is compound sectional shielding aluminium tubular busbar, FLMFZ is compound sectional pole insulator aluminium busbar.

2.5 绝缘母线配套金具

Power fittings attached to insulation busbar

我公司绝缘管母线产品针对用户均为“交钥匙”工程, 整体服务包含母线设计、测量、制造、试验、安装、维护于一体。并包含母线的安装金具及附件。所有金具及材料均由我公司生产配套, 具体金具规格如下:

The insulated tubular busbar products of our company belongs to “Turn key project” to customers, integrated service of which includes designation, measurement, manufacture, test, installation and maintenance as well as power fittings and necessary accessories. All the power fittings and materials are manufactured by us, specifications as follows:

序号 NO.	名称 Name	规格型号 Spec. & Model	备注 Remarks
1	固定金具 Busbar supports	GMG-100	适用Φ100外径管母线, 若采用Φ80则为GMG-80 Applicable for busbar of Φ100, if applicable to busbar of Φ80, the spec. & model will be GMG-80.
2	中间接头 Intermediate splice	GMZ-100	适用Φ100外径管母线, 若采用Φ80则为GMZ-80 Applicable for busbar of Φ100, if applicable to busbar of Φ80, the spec. & model will be GMZ-80.
3	终端接头 Terminal connectors	GMD-100	适用Φ100外径管母线, 若采用Φ80则为GMD-80 Applicable for busbar of Φ100, if applicable to busbar of Φ80, the spec. & model will be GMD-80.
4	T型接头 T Joints	GMTJ-100	适用Φ100外径管母线, 若采用Φ80则为GMTJ-80 Applicable for busbar of Φ100, if applicable to busbar of Φ80, the spec. & model will be GMTJ-80.
5	绝缘屏蔽筒 Insulation shielding tube	JRPBT-9000A	统一按9000A配置 Configurable as per 9000A.
6	伸缩节 Expansion joints	GMSSJ-4000A	为额定电流4000A型号, 若其它规格相应改变 For rated current of 4000A.
7	托架 Busbar supports	GMT-100	



1、铝及铝合金管母线

Aluminium & Aluminium Tubular Busbar

► 化学成分 Chemical composition

牌 号	化学成分(%)						
	Si	Fe	Mg	Mn	Cu	Re	Zr
铝锰合金系列3A21 (LF21)	0.6	0.7	0.05	1.0-1.6	0.2	-	-
铝镁合金系列6063G (6063)	0.2-0.6	0.35	0.45-0.9	0.10	0.10	-	-
铝镁稀土合金系列LDRE (6R05)	0.2-0.6	0.3-0.5	0.40-0.9	0.10	0.15-0.25	0.10-0.20	-
耐热铝合金系列6Z63	0.2-0.6	0.35	0.45-0.9	0.10	0.1-0.2	0.07-0.16	0.08-0.20

► 规格范围 A available specification

公称外径mm	壁 厚 mm										长度 mm	
	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.0	15.0	18.0		
80	✓	✓										<13
90	✓	✓	✓									<13
100	✓	✓	✓	✓	✓							<13
110	✓	✓	✓	✓	✓							<13
120		✓	✓	✓	✓							<13
130		✓	✓	✓	✓	✓	✓					<13
150			✓	✓	✓	✓	✓					<13
170			✓	✓	✓	✓	✓					<13
200					✓	✓	✓					<13
250						✓	✓	✓	✓			<13
280							✓	✓	✓			<13
300									✓	✓		<12
320									✓	✓		<11

注：“✓”表示可供货范围，需要其他规格时，可供需双方协商。



► 几何参数 Geometric parameter

导体尺寸D/d mm	截面积 S mm ²	截面系数 W cm ³	惯性半径 r1 cm	惯性矩 L Cm ⁴	供货长度 L m
Φ80/72	954	17.61	2.69	69.2	<13
Φ100/90	1491	35.2	3.36	169	<13
Φ110/100	1649	42.25	3.72	228	<13
Φ120/110	1806	50.84	4.07	299	<13
Φ130/116	2705	80.4	4.36	513	<13
Φ130/110	3768	107.1	4.26	683	<13
Φ150/136	3145	109.4	5.06	806	<13
Φ170/156	3583	143	5.77	1192	<13
Φ170/154	4072	160.3	5.73	1339	<13
Φ170/150	5024	193.5	5.67	1614	<13
Φ200/180	5966	275.1	6.73	2700	<13
Φ250/230	7540	443.1	8.49	5435	<13
Φ250/226	8968	519	8.43	6365.8	<13
Φ280/256	10098	662.3	9.48	9084	<13
Φ300/270	13423.5	928.5	10.09	13667	<12
Φ320/290	14365.5	1066.5	107.96	16745	<11

► 物理性能 Physical property

性能	合金牌号			
	3A21(LF21)	6063G(6063)	LDRE(6R05)	6Z63
密度(g/cm ³)(20℃)	2.74	2.75	2.75	2.75
熔点℃	646~656	620~640	620~640	628~668
导热系数(卡/℃×cm×s)	0.46	0.5	0.51	0.51
相对导电率IACS%	41	56	56.5	56.5
泊松比μ	0.305	0.315	0.317	0.317
20℃电阻温度系数1/℃	0.0042	0.0041	0.0041	0.0041
温度线膨胀系数(1/℃)(20~100℃)	22.6×10 ⁻⁶	23.4×10 ⁻⁶	24.7×10 ⁻⁶	24.7×10 ⁻⁶
20℃电阻率ρ, Ω·mm ² /m	0.043	0.032	0.031	0.031
弹性模量E(MPa)	71000	72000	72000	72000
最高允许工作温度	80℃~100℃	80℃~100℃	80℃~100℃	150℃~200℃

► 力学性能 Mechanical property

合金牌号	状态	力学性能						备注
		抗拉强度σ _b (Mpa)		屈服强度σ _{0.2} (Mpa)		延伸率δ(%)		
		标准值	实测值	标准值	实测值	标准值	实测值	
3A21(LF21)	H14	>135	>160	—	>130	—	>15	GB/T6893-2000
6063G(6063)	T10	>180	>206	>160	>170	—	>12	YS/T454-2003
	T6	>205	>225	>175	>190	>8	>12	
LDRE(6R05)	T10	>185	>210	>165	>175	—	>12	
	T6	>210	>230	>180	>200	>8	>12	
6Z63	T10	>190	>220	>170	>180	>9	>12	Q/XH01-2008
	T6	>220	>240	>190	>205	>8	>12	

► 尺寸公差 Dimensional tolerance
外径公差 OD tolerance (mm)

公称外径	平均外径与公称外径的允许偏差	任一外径与公称外径的允许偏差	
		H14	T10、T6
>50.00~80.00	±0.20	±0.20	±0.25
>80.00~130.00	±0.28	±0.28	±0.30
>130.00~150.00	±0.35	±0.35	±0.38
>150.00~200.00	±0.54	±0.54	±0.57
>200.00~250.00	±0.70	±0.70	±0.77
>250.00~300.00	±0.80	±0.80	±0.90
>300.00~350.00	±1.20	±1.20	±1.50

注1:当产品标准或合同中要求直径偏差全为(+)或全为(-)时,其偏差值为上表中对应数值的2倍。
注2:任一外径是指在管材断面上任一点测得的外径;平均外径是指在管材断面上测量任意两个互为直角的外径所得的平均值。

壁厚公差 Thickness tolerance (mm)

公称壁厚	平均壁厚与公称壁厚的允许偏差	任一壁厚与公称壁厚的允许偏差	
		H14	T10、T6
>3.00~5.00	±0.30	±0.40	规定壁厚 的12% 最大值1.20
>5.00~8.00	±0.50	±0.60	
>8.00~10.00	±0.60	±0.90	
>10.00~12.00	±0.85	±1.10	
>12.00~15.00	±1.00	±1.30	
>15.00~20.00	±1.15	±1.45	

注1:任一壁厚是指在管材断面上任一点测得的壁厚;平均壁厚是指在管材断面的外径两端测得壁厚的平均值。
注2:当产品标准或合同中要求壁厚偏差全为(+)或全为(-)时,其偏差值为上表中对应数值的2倍。

弯曲度允许偏差 Bending is allowed tolerance(mm)

公称外径	弯曲度,不大于	
	每1000mm长度上	全长度(L米)上
<150.00	1	1×L
>150.00	2	2×L





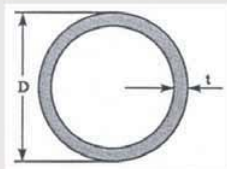
► 载流量 Ampacity (A) 环境温度 Ambient temperature (20°C)

材质 型号 温升	3A21 (LF21)		6063G (6063)		LDRE (6R05)		6Z63	
	+70K	+80K	+70K	+80K	+70K	+80K	+70K	+80K
Φ80/72	1320	1470	-	-	-	-	-	-
Φ100/90	1980	2300	2681	2903	3260	3490	3383	3538
Φ110/100	2190	2543	2901	3144	3610	3790	3736	3860
Φ120/110	2368	2766	3118	3382	3810	4100	3985	4208
Φ130/116	3460	3820	3910	4244	4410	4630	4496	4880
Φ130/110	3980	4500	4615	5011	5315	5421	5507	5762
Φ150/136	3990	4350	4516	4891	5350	5880	5566	5968
Φ170/156	4356	4720	4891	5327	5710	6116	5824	6226
Φ170/154	4470	4850	5213	5677	6560	6910	6630	7060
Φ170/150	4710	5020	5792	6308	6750	7190	7160	7480
Φ200/180	5600	5900	7906	8426	8330	8860	8540	8990
Φ250/230	-	-	8512	9168	8870	9540	9177	10543
Φ250/226	-	-	9391	10142	9660	10610	10569	11663
Φ280/256	-	-	10374	11445	11250	11960	11930	13161
Φ300/270	-	-	13690	15114	14600	16330	15743	17381
Φ320/290	-	-	14550	16074	16060	17478	16732	18485

► 母线安装说明 Busbar Installation Directions

○ 常用母线、衬管、封端球及封端盖配合尺寸

Common busbar, liner tube, end ball and end-cups for tublar busbar (mm)



主管 Busbar			衬管 Liner tube			封球或封盖 End ball and end-cup for tublar busbar
D,mm	t,mm	重量kg/m	D,mm	t,mm	重量kg/m	外径 D
80	4	2.61	71	4	2.30	71
90	5	3.64	79	5	3.17	79
100	5	4.07	89	5	3.60	89
110	5	4.50	99	5	4.03	99
120	5	4.93	109	5	4.46	109
130	7	7.38	115	7	6.48	115
150	7	8.58	135	7	7.68	135
170	8	11.05	153	8	9.98	153
170	10	13.72	149	10	11.92	149
200	10	16.30	179	10	14.49	179
250	10	20.60	229	10	19.60	229
250	12	24.66	225	12	22.10	225
280	12	27.77	255	12	25.18	255
300	15	36.91	269	15	32.90	269
320	15	39.51	289	15	35.49	289



► 母线焊接 Busbar welding

接头处坡口图形及尺寸: Graphics and size for divided edge

坡口图形	管厚度 δ,mm	间隙 c,mm	钝边厚度 b,mm	坡口厚度 α度
	3.5~10	5~10	0.5~2	45~65

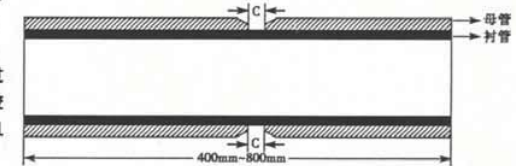
填充材料(焊丝)成份: Welding material ingredient

母材	焊接材料	化学成分					
		Fe	Si	Mg	Mn	Cu	Al
3A21	铝锰焊丝(S321)	0.70	0.60	-	1.0~1.6	-	余量
6063G (6063) LDRE (6R05) 6Z63	铝镁焊丝(S331)	0.40	0.25	2.4~3.0	0.5~1.0	0.10	余量

○ 管母线焊接

管型导体一般采用焊接后架空安装(铝及铝合金管焊接方式类似),架空后管型导体采用专用的管母线金具固定,由于在焊接后接头处的强度有所降低(国标要求为母材的62%),为避免架空后接头处在使用中发生弯曲,接头处内部应用衬管进行加固,两架空支柱之间焊接头不应多于两个。常用铝及铝合金管焊接方法如下:

氩弧焊(MIG焊接),氩弧焊接是在氩气保护下,用交流或直流焊接电源,通过难熔的钨极为不熔化电极,使它与工件产生电弧,以熔化填充材料和工件接口进行焊接,与气焊相比,它的优点是热量集中,电弧稳定,熔化金属既能得到氩气的良好保护,避免氧化,又能将熔化的金属表面的氧化膜通过氩弧予以清除而不用焊药,因此既能获得缺陷较少又纯净的优质焊缝,又能较易掌握焊接技术且能进行全位置焊接。



● Busbar welding

Busbar is usually installed overhead after being welded(welding process for aluminium tube is the same),adopting specialized busbar supports to fix it after being built on stilts,owing to somewhat decrease of intensity of the welded joints,the inner joints must be reinforced by liner tube,no more than 2 welded joints between two aerial poles,so as to protect the welded joints from bending after built on stilts.Welding process for aluminium and aluminium alloy pipe is as follows,Argon-arc welding argon shield tungsten electrode workpiece arcing

Uses DC or AC current supply and refractory tungsten as infusible electrode,argon gas as shield gas to make arcing and melt filling materials with workpiece interface so as to perform the welding,compared with gas welding,it has advantages of heat concentrating,steady arc,Not only the molten metal can be perfectly protected by argon gas from oxidation but also eliminate oxide film on the surface of the molten metal by argon arc instead of using welding flux,so excellent quality welding line with less defect can be obtained and very easy to master welding technology to achieve all position welding.



2、复合屏蔽绝缘铜(铝)管母线

Compound insulated shielding copper(aluminium) tubular busbar

▶ 表一：0.4KV绝缘铜管母线技术数据和导体规格

Table 1 specifications for 0.4kV insulated copper tubular busbar

额定电流 Rated current	导体直径 Conductor diameter	1min工频 耐压水平 1 min power frequency withstand voltage	热稳定 电流 有效值 Thermal current effective value	动稳定电 流峰值 Dynamics current peak value	截面积 Sectional area	标准弯 曲半径 Standard bending radius	温升 Temperature rise	最小相间 距离 Min. interphase spacing	母线 最大 跨距 Max. Span
A	mm	kV	kA	kA	mm ²	mm	K	mm	M
1600	φ60×6	2	40	100	1017	140-350	≤40	≥275	≤6
2000	φ60×8	2	40	100	1165				
2500	φ80×6	2	40	100	1394				
3150	φ100×6	2	40	100	1771	350			
4000	φ100×10	2	63	158	2826				
5000	φ100×12	2	63	158	3316	350			
6300	φ100×6 两根(2 pcs)	2	63	158	3542	350		≥275	≤10
	φ170×7				3583	770		≥400	
7000	φ100×8 两根(2 pcs)	2	63	158	4622	350		≥275	≤10
	φ170×9				4550	770		≥400	
9000	φ100×12 两根(2 pcs)	2	63	158	6632	350	≥275	≤10	
	φ170×12				6410	770	≥400		

备注：根据变压器及相连接的设备的最大电流，经协商后在保证导体载流量的情况下，以上导体规格可以调整。

Marks: According to the largest current of the transformer and connected equipments, the above specifications of conductor can be adjusted after negotiation based on assurance of the current capacity.



▶ 表二：6KV绝缘铜管母线技术数据和导体规格

Table 2 specifications for 6kV insulated copper tubular busbar

额定电流 Rated current	导体直径 Conductor diameter	1min工频 耐压水平 1 min power frequency withstand voltage	热稳定 电流 有效值 Thermal current effective value	动稳定电 流峰值 Dynamics current peak value	截面积 Sectional area	标准弯 曲半径 Standard bending radius	温升 Temperature rise	最小相间 距离 Min. interphase spacing	母线 最大 跨距 Max. Span
A	mm	kV	kA	kA	mm ²	mm	K	mm	M
1600	φ60×6	24	40	100	1017	140-350	≤40	≥275	≤6
2000	φ60×8	24	40	100	1165				
2500	φ80×6	24	40	100	1394				
3150	φ100×6	24	40	100	1771	350			
4000	φ100×10	24	63	158	2826				
5000	φ100×12	24	63	158	3316	350			
6300	φ100×6 两根(2 pcs)	24	63	158	3542	350		≥275	≤10
	φ170×7				3583	770		≥400	
7000	φ100×8 两根(2 pcs)	24	63	158	4622	350		≥275	≤10
	φ170×9				4550	770		≥400	
9000	φ100×12 两根(2 pcs)	24	63	158	6632	350	≥275	≤10	
	φ170×12				6410	770	≥400		

备注：根据变压器及相连接的设备的最大电流，经协商后在保证导体载流量的情况下，以上导体规格可以调整。

Marks: According to the largest current of the transformer and connected equipments, the above specifications of conductor can be adjusted after negotiation based on assurance of the current capacity.



▶ 表三：10KV绝缘铜管母线技术数据和导体规格

Table 3 specifications for 10kV insulated copper tubular busbar

额定电流 Rated current	导体直径 Conductor diameter	1min工频 耐压水平 1 min power frequency withstand voltage	热稳定 电流 有效值 Thermal current effective value	动稳定电 流峰值 Dynamics current peak value	截面积 Sectional area	标准弯 曲半径 Standard bending radius	温升 Temperature rise	最小相间 距离 Min. interphase spacing	母线 最大 跨距 Max. Span	
A	mm	kV	kA	kA	mm ²	mm	K	mm	M	
1600	Φ60×6	42	40	100	1017	140-350	≤40	≥275	≤6	
2000	Φ60×8	42	40	100	1165					
2500	Φ80×6	42	40	100	1394					
3150	Φ100×6	42	40	100	1771	350		≥275	≤10	
4000	Φ100×10	42	63	158	2826					
5000	Φ100×12	42	63	158	3316	350		≥275	≤10	
6300	Φ100×6 两根(2 pcs)	42	63	158	3542	350				≥400
	Φ170×7				3583	770		≥275		
7000	Φ100×8 两根(2 pcs)	42	63	158	4622	350		≥400	≥275	≤10
	Φ170×9				4550	770		≥275		
9000	Φ100×12 两根(2 pcs)	42	63	158	6632	350	≥400	≥275	≤10	
	Φ170×12				6410	770	≥275			

备注：根据变压器及相连接的设备的最大电流，经协商后在保证导体载流量的情况下，以上导体规格可以调整。

Marks: According to the largest current of the transformer and connected equipments, the above specifications of conductor can be adjusted after negotiation based on assurance of the current capacity.



▶ 表四：35KV绝缘铜管母线技术数据和导体规格

Table 4 specifications for 35kV insulated copper tubular busbar

额定电流 Rated current	导体直径 Conductor diameter	1min工频 耐压水平 1 min power frequency withstand voltage	热稳定 电流 有效值 Thermal current effective value	动稳定电 流峰值 Dynamics current peak value	截面积 Sectional area	标准弯 曲半径 Standard bending radius	温升 Temperature rise	最小相间 距离 Min. interphase spacing	母线 最大 跨距 Max. Span	
A	mm	kV	kA	kA	mm ²	mm	K	mm	M	
1600	Φ60×6	105	40	100	1017	140-350	≤40	≥275	≤6	
2000	Φ60×8	105	40	100	1165					
2500	Φ80×6	105	40	100	1394					
3150	Φ100×6	105	40	100	1771	350		≥275	≤10	
4000	Φ100×10	105	63	158	2826					
5000	Φ100×12	105	63	158	3316	350		≥275	≤10	
6300	Φ100×6 两根(2 pcs)	105	63	158	3542	350				≥400
	Φ170×7				3583	770		≥275		
7000	Φ100×8 两根(2 pcs)	105	63	158	4622	350		≥400	≥275	≤10
	Φ170×9				4550	770		≥275		
9000	Φ100×12 两根(2 pcs)	105	63	158	6632	350	≥400	≥275	≤10	
	Φ170×12				6410	770	≥275			

备注：根据变压器及相连接的设备的最大电流，经协商后在保证导体载流量的情况下，以上导体规格可以调整。

Marks: According to the largest current of the transformer and connected equipments, the above specifications of conductor can be adjusted after negotiation based on assurance of the current capacity.



▶ 表五：0.4KV绝缘铝管母线技术数据和导体规格

Table 5 specifications for 0.4kV insulated aluminium tubular busbar

额定电流 Rated current	导体直径 Conductor diameter	1min工频 耐压水平 1 min power frequency withstand voltage	热稳定 电流 有效值 Thermal current effective value	动稳定电 流峰值 Dynamics current peak value	截面积 Sectional area	标准弯 曲半径 Standard bending radius	温升 Temperature rise	最小相间 距离 Min. interphase spacing	母线 最大跨距 Max. Span
A	mm	kV	kA	kA	mm ²	mm	K	mm	M
1600	Φ100×7	2	40	100	2044	350	≤40	≥275	≤8
2000	Φ100×8	2	40	100	2311				
2500	Φ100×10	2	40	100	2826				
3150	Φ100×12	2	40	100	3316				
4000	Φ100×14	2	63	158	4660				

备注：根据变压器及相连接的设备的最大电流，经协商后在保证导体载流量的情况下，以上导体规格可以调整。

Marks: According to the largest current of the transformer and connected equipments, the above specifications of conductor can be adjusted after negotiation based on assurance of the current capacity

▶ 表六：6KV绝缘铝管母线技术数据和导体规格

Table 6 specifications for 6kV insulated aluminium tubular busbar

额定电流 Rated current	导体直径 Conductor diameter	1min工频 耐压水平 1 min power frequency withstand voltage	热稳定 电流 有效值 Thermal current effective value	动稳定电 流峰值 Dynamics current peak value	截面积 Sectional area	标准弯 曲半径 Standard bending radius	温升 Temperature rise	最小相间 距离 Min. interphase spacing	母线 最大跨距 Max. Span
A	mm	kV	kA	kA	mm ²	mm	K	mm	M
1600	Φ100×7	24	40	100	2044	350	≤40	≥275	≤8
2000	Φ100×8	24	40	100	2311				
2500	Φ100×10	24	40	100	2826				
3150	Φ100×12	24	40	100	3316				
4000	Φ100×14	24	63	158	4660				

备注：根据变压器及相连接的设备的最大电流，经协商后在保证导体载流量的情况下，以上导体规格可以调整。

Marks: According to the largest current of the transformer and connected equipments, the above specifications of conductor can be adjusted after negotiation based on assurance of the current capacity



▶ 表七：10KV绝缘铝管母线技术数据和导体规格

Table 3 specifications for 10kV insulated aluminium tubular busbar

额定电流 Rated current	导体直径 Conductor diameter	1min工频 耐压水平 1 min power frequency withstand voltage	热稳定 电流 有效值 Thermal current effective value	动稳定电 流峰值 Dynamics current peak value	截面积 Sectional area	标准弯 曲半径 Standard bending radius	温升 Temperature rise	最小相间 距离 Min. interphase spacing	母线 最大跨距 Max. Span
A	mm	kV	kA	kA	mm ²	mm	K	mm	M
1600	Φ100×7	42	40	100	2044	350	≤40	≥275	≤8
2000	Φ100×8	42	40	100	2311				
2500	Φ100×10	42	40	100	2826				
3150	Φ100×12	42	40	100	3316				
4000	Φ100×14	42	63	158	4660				

备注：根据变压器及相连接的设备的最大电流，经协商后在保证导体载流量的情况下，以上导体规格可以调整。

Marks: According to the largest current of the transformer and connected equipments, the above specifications of conductor can be adjusted after negotiation based on assurance of the current capacity

▶ 表八：35KV绝缘铝管母线技术数据和导体规格

Table 8 specifications for 35kV insulated aluminium tubular busbar

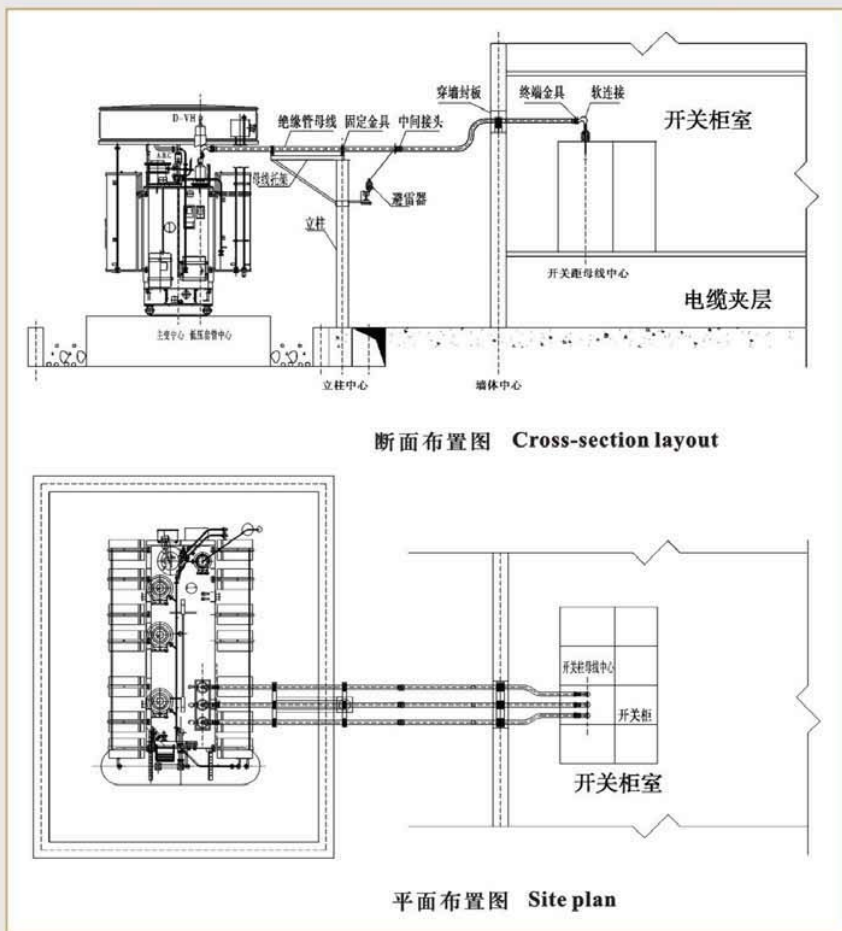
额定电流 Rated current	导体直径 Conductor diameter	1min工频 耐压水平 1 min power frequency withstand voltage	热稳定 电流 有效值 Thermal current effective value	动稳定电 流峰值 Dynamics current peak value	截面积 Sectional area	标准弯 曲半径 Standard bending radius	温升 Temperature rise	最小相间 距离 Min. interphase spacing	母线 最大跨距 Max. Span
A	mm	kV	kA	kA	mm ²	mm	K	mm	M
1600	Φ100×7	105	40	100	2044	350	≤40	≥275	≤8
2000	Φ100×8	105	40	100	2311				
2500	Φ100×10	105	40	100	2826				
3150	Φ100×12	105	40	100	3316				
4000	Φ100×14	105	63	158	4660				

备注：根据变压器及相连接的设备的最大电流，经协商后在保证导体载流量的情况下，以上导体规格可以调整。

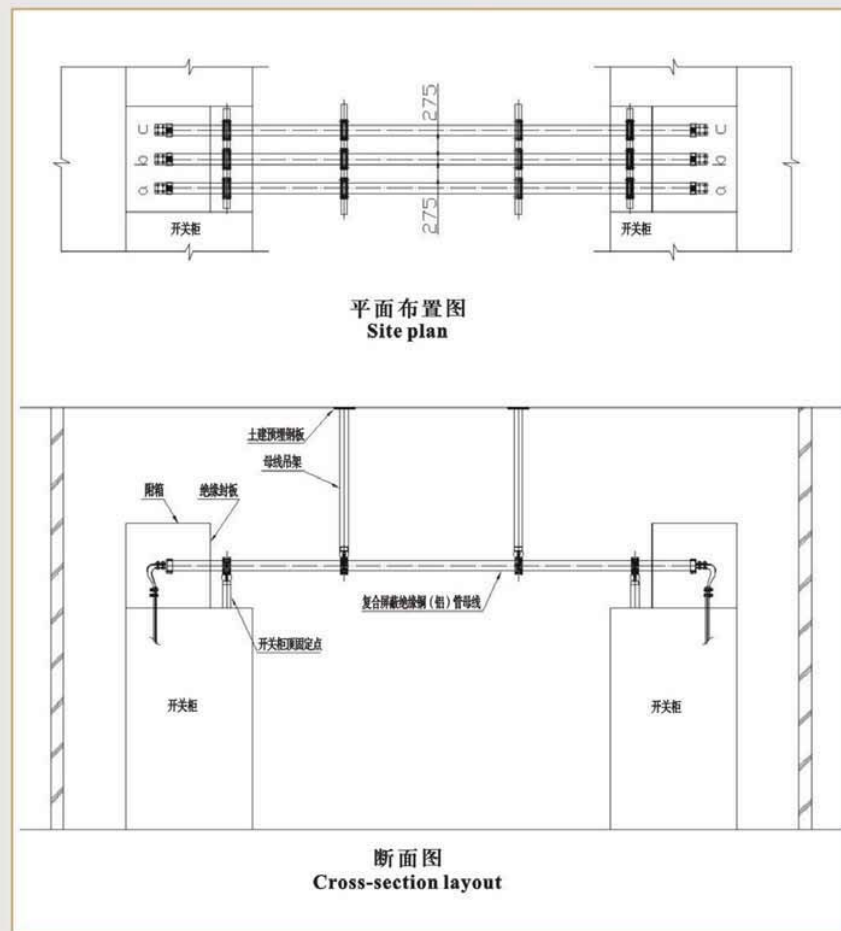
Marks: According to the largest current of the transformer and connected equipments, the above specifications of conductor can be adjusted after negotiation based on assurance of the current capacity

▶ 附录：典型设计 Appendix: typical design

1、变压器与开关柜的连接 Transformers and switchgear connections

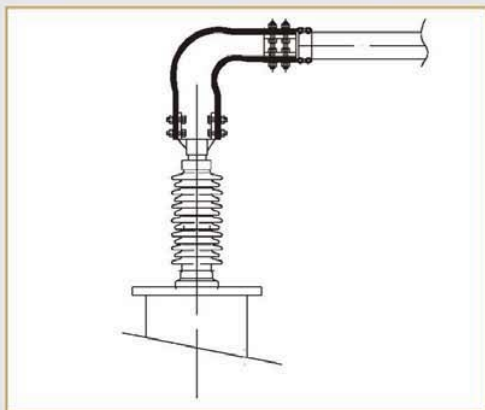


2、开关柜母线连接 Switchgear busbar connection

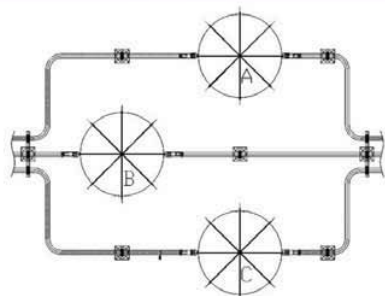


3、母线与设备连接 Busbar and equipment connected

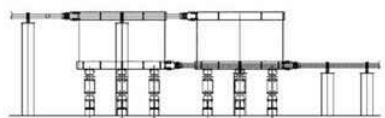
3.1 与低压套管连接 Connected with the low-pressure pipe



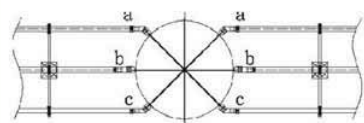
3.2 与电抗器连接 Connected with the electric reactor



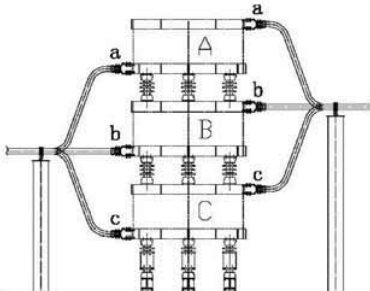
平面布置图 Site plan



断面布置图 Cross-section layout

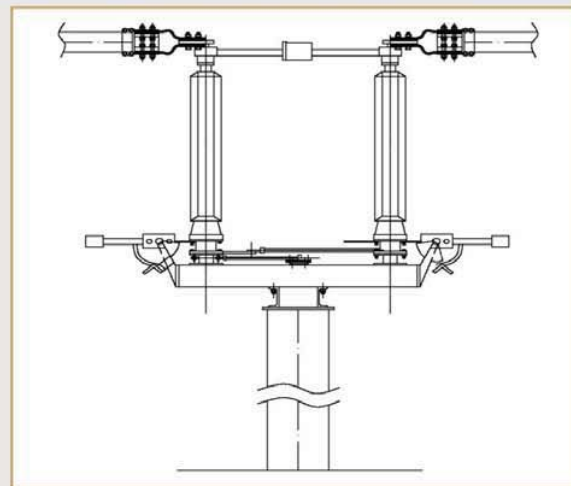


平面布置图 Site plan

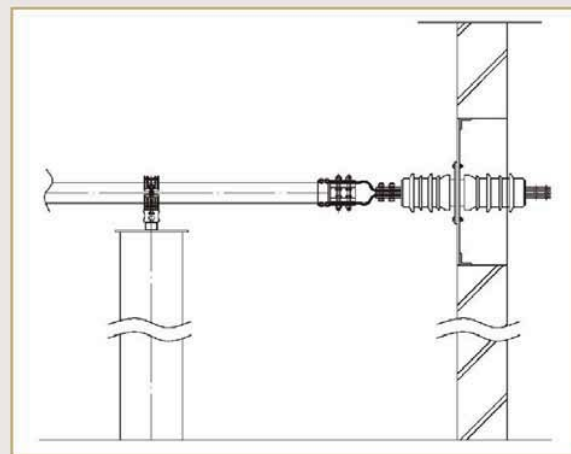


断面布置图 Cross-section layout

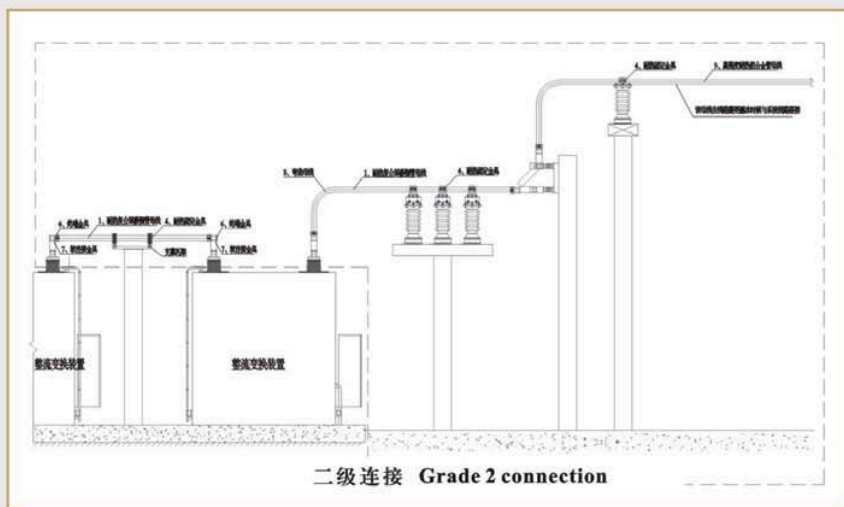
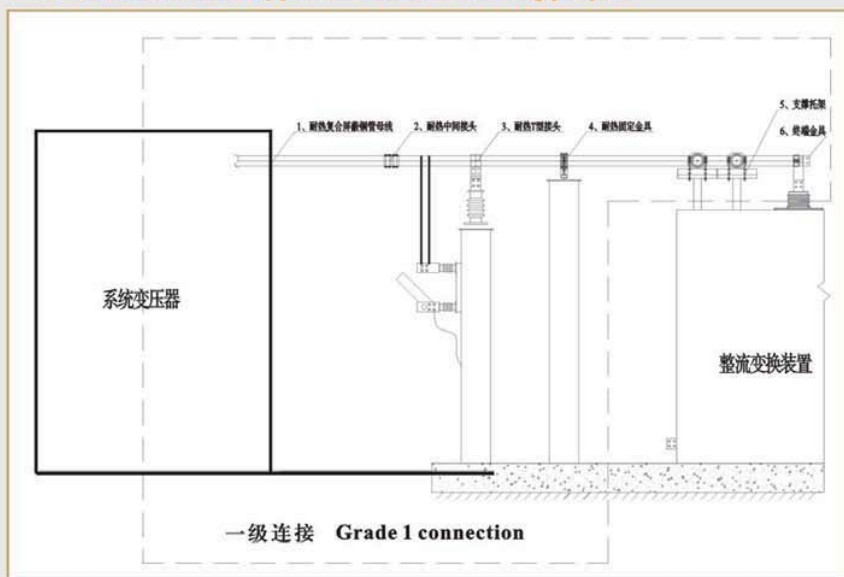
3.3 与隔离开关连接 With the isolation switch to connect



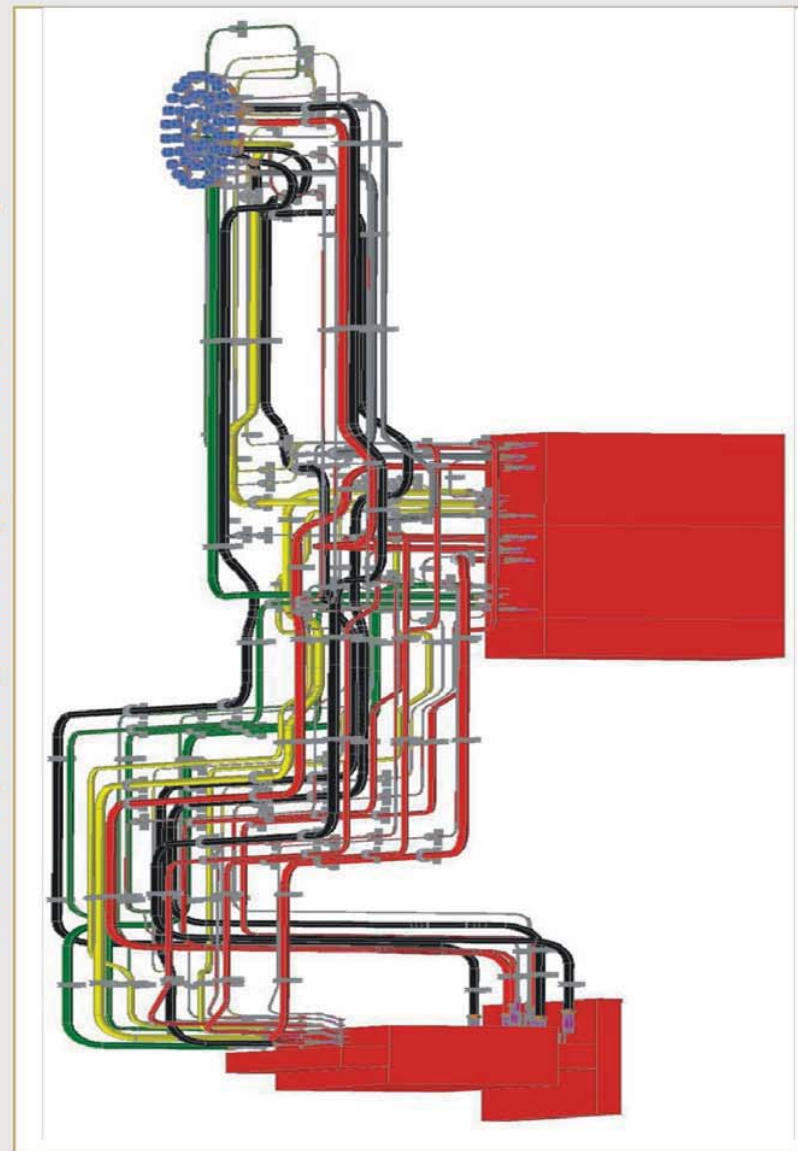
3.4 与穿墙套管连接 Connected with the wall bushing



4、融冰工程的应用 Application of ice-melting project



5、绝缘母线在多晶硅系统中应用的三维效果图
Insulated busbar system, the application of the poly-Si three-dimensional renderings





铝及铝合金管母线

ALUMINIUM & ALUMINIUM TUBULAR BUS BAR

复合绝缘铜（铝）管母线

COMPOUND INSULATED SHIELDING COPPER (ALUMINIUM) TUBULAR BUSBAR

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